

Whether Arsenic Can Activate Neutrophil Degranulation and Induce Lung Cell Damage in Mice

Mengbo Liu

*Department of Biological Sciences, Auburn University, Auburn, USA
liumengbo8123@163.com*

Abstract: In recent years, many studies have discovered the toxic effects of heavy metal substances on different organs. Among them, heavy metals such as lead (Pb) and arsenic (As) are substances that can cause serious harm to human health. Lead exposure has been shown to induce early myocardial injury primarily by promoting neutrophil degranulation. This process triggers an inflammatory response in heart cells by promoting the release of elastase, which ultimately damages heart cells and tissues. Arsenic is a ubiquitous heavy metal substance that is usually found in inorganic forms such as arsenite and arsenate. Arsenic is mainly exposed to the human body through water, which also affects the health of more than 200 million people worldwide. Lung cells are particularly susceptible to arsenic toxicity. Since arsenic ($>10\text{ }\mu\text{g/L}$) causes damage to the lungs, and lead (Pb) causes an inflammatory response by promoting neutrophil degranulation, which in turn leads to heart tissue damage, I wonder if the damage to the lungs caused by arsenic exposure is similar to the process of lead-induced heart tissue damage. The results will increase our understanding of the processes and mechanisms of arsenic-induced lung cell injury. It will increase our understanding of the effects of arsenic on the human lungs, leading to increased awareness and improved human health. It also provides possible directions for the treatment of patients with lung diseases caused by arsenic exposure.

Keywords: Neutrophil degranulation, Arsenic exposure

1. Introduction

In recent years, a large number of studies have shown that heavy metals have toxic effects on different organs. Heavy metals are one of the environmental toxicants. Lead (Pb) is one of the substances that cause early myocardial damage. There is ample evidence that lead (Pb) exposure can induce early myocardial damage, mainly by promoting neutrophil degranulation. This process involves the release of enzymes such as elastase, leading to an inflammatory response and subsequent damage to cardiac tissue [1]. However, we do not know enough about the effects of environmental toxins other than lead on different organs, including arsenic (As).

Arsenic is an important environmental pollutant that exists throughout the world in the form of inorganic arsenic compounds, the most common forms of which are arsenite and arsenate [2]. Arsenic affects the human body through water, air, and food, and water is the main source of arsenic exposure [3]. Although the World Health Organization (WHO) has regulations on arsenic concentrations in water ($<10\text{ }\mu\text{g/L}$), it has been investigated that more than 200 million people are still exposed to

excessive arsenic-contaminated groundwater worldwide [4]. Although arsenic affects many tissues and organ systems, the lungs as a unique target organ seem to be particularly susceptible [5].

Arsenic is a metalloid that can cause lung cell poisoning due to its irritating effect on the lungs. High-concentration arsenic exposure is closely associated with lung cancer, as confirmed by epidemiological statistical analyses in China, the United States, Italy, and Chile [6]. At the same time, high levels of arsenic contamination in Argentina are also associated with increased incidence of chronic diseases such as lung cancer. Due to the harmful effects of arsenic on the lungs, we will see an increase in the incidence of lung disease with higher arsenic exposure concentrations; however, the specific mechanism by which arsenic damages lung cells is unclear. Based on the established mechanism of neutrophil degranulation causing lead-induced myocardial injury, it can be hypothesized that arsenic exposure can cause neutrophil degranulation. The whole process will lead to the release of some pro-inflammatory mediators, triggering lung inflammation and lung cell damage.

This article will focus on the effects of arsenic exposure on mouse lung cells. By putting quantitative, different concentrations of arsenic into the food and drinking water of mice, the mouse lungs will be affected by arsenic. Then, the content of elastin in the mouse serum will be tested to determine whether arsenic causes neutrophil degranulation. Alternatively, the damage to the mouse lung cells can be further determined by observing the lung cells of diseased mice.

Hypothesis:

I predict that increasing concentrations and treatment durations of mice with Arsenic will increase release Elastase from neutrophil degranulation, thereby triggering lung inflammation and causing lung cell damage.

2. Material and methods

Material: Adult mice in the same state of life and health. Prepare eight groups of arsenic solutions with different concentrations (5ug/L, 10ug/L, 40ug/L, 80ug/L, 100ug/L, 120ug/L, 150ug/L, and 200ug/L) for normal saline.

Method 1: ELISA Method

The level of elastase in serum is measured by ELISA. Eight groups of mice (10 mice in each group) that were in the same healthy state are treated with eight different concentrations of arsenic solution. After fifteen days, the level of elastase in serum is measured by ELISA. The results are compared with those of mice treated with saline.

Method 2: TNF-alpha ELISA Method

Inflammation in serum is detected by TNF-alpha ELISA. Eight groups of mice (10 mice in each group) that were in the same healthy state are treated with eight different concentrations of arsenic solution. After fifteen days, the level of the pro-inflammatory cytokine TNF-alpha in the serum of mice is measured. The results are compared with those of the negative control group of mice treated with saline. Determine whether the experimental group of mice is inflamed.

Method 3: Observation of cells under a microscope

Use a microscope to observe the damage of mouse lung cells. Eight groups of mice (10 mice in each group) that were in the same healthy state are treated with eight different concentrations of arsenic solution. Fifteen days later, lung cells were carefully removed from the mice to look for signs of lung cell damage. The damage observed was compared with a negative control group treated with saline to assess the extent of the damage.

Statistical Analysis: I will use 10 mice of similar physical condition in each experimental group to ensure consistency and reliability of the results. To analyze the data collected from these groups, I will use the Student's t-test to determine the differences observed between the experimental and

control groups. In addition, I will perform replicates to reduce the effects of biological variability on the experimental results.

3. Results

Table 1: Possible results

Combination Result # (CR#)				
	Increase Neutrophil Elastase by ELISA	Increased TNF α by ELISA	Increase lung damage by Confocal Microscopy	Support of hypothesis
1	+	+	+	Full
2	+	+	-	Partial
3	+	-	+	Partial
4	-	+	+	Partial
5	-	-	+	Partial
6	-	+	-	Partial
7	-	-	+	Partial
8	-	-	-	Fully Contradicts

Table legend: "+" indicates increased content or cell damage, "-" indicates there was no significant difference with the control group

CR1: If I got this result, I would see elastase increased in serum. Inflammation occurred in mice. Under a microscope, lung cells of mice were damaged.

CR2: If I get this result, I would see elastase increased in serum. Inflammation occurred in the mice. No damage was found in the mice's lung cells under a microscope.

CR3: If I get this result, I would see elastase increased in the mouse serum. No inflammation was found in the mice. Under the microscope, the mice's lung cells were damaged.

CR4: If I get this result, I would see the elastase content in the mouse serum did not change. Inflammation occurred in the mice. Under the microscope, the mouse lung cells were damaged.

CR5: If I get this result, I would see there was no change in the elastase content in the mouse serum. No inflammation was found in the mice. Under the microscope, the lung cells of the mice were damaged.

CR6: If I get this result, I would see the elastase content in the mouse serum did not change. Inflammation occurred in the mice. Under the microscope, the mouse lung cells showed no damage.

CR7: If I get this result, I would see there was no change in the elastase content in the mouse serum. No inflammation was found in the mice. Under the microscope, the lung cells of the mice were damaged.

CR8: If I get this result, I would see there was no change in the elastase content in the mouse serum, no inflammation in the mouse body, and no damage to the mouse lung cells under the microscope.

4. Discussion

High concentrations of arsenic are known to be toxic and pathogenic, especially in the lungs. Most studies have reported that lung cancer incidence and mortality are significantly higher in people with high arsenic exposure than in the general population or people with low arsenic exposure[7-9]. The

first possible outcome is similar to the assumptions. The second possible outcome contradicts the assumptions.

CR1: This set of experiments is completely consistent with the hypothesis, and he proved that the effect of arsenic on lung cells is likely due to neutrophil degranulation leading to inflammation, and finally causing damage to lung cells.

CR2: This set of experiments observed no damage to lung cells, probably because the mice have their own compensation mechanisms. Arsenic exposure also caused neutrophil degranulation and triggered inflammation in the mice. Next, the experiment could be extended to observe whether there is any damage to the lung cells.

CR3: This set of experiments observed no inflammation in the mice. However, elastase levels were elevated and lung cells were damaged. Arsenic exposure may cause local lung tissue damage, but it did not trigger a systemic inflammatory response. The experiment can be extended to see if lung cell damage becomes more severe and if inflammation occurs in the mice.

CR4: This set of experiments observed no inflammation in the mice. However, elastase levels were elevated and lung cells were damaged. Arsenic exposure may cause local lung tissue damage, but it did not trigger a systemic inflammatory response. The experiment can be extended to see if lung cell damage becomes more severe and if inflammation occurs in the mice.

CR5: In this set of experiments, there was no inflammation and high levels of elastase in the serum. This proves that the lung damage caused by arsenic exposure may not be caused by inflammatory mediators and reactions. Arsenic-induced lung damage may be due to direct toxic effects on lung cells.

CR6: This group of experiments did not have high levels of elastase in the serum, and the lung cells were not damaged. This result may be because arsenic exposure does not affect neutrophils, and it is due to other body mechanisms that cause inflammation in the mice. It may be that the lung cells of mice have a compensatory mechanism and the lung cells are not damaged in the short term. Extend the experiment time and observe whether the lung cells of the mice are damaged.

CR7: In this set of experiments, there was no high level of elastase in the serum, and no inflammation in the mice. This proves that the damage to lung cells by arsenic does not match the hypothesis. Lung damage may be due to other reasons such as disruption of cell signaling pathways.

CR8: In this group of experiments, there was no high level of elastase in the serum, no inflammation in the mice, and no damage to the lung cells. Such experimental results are completely inconsistent with the hypothesis. However, based on known information, it is highly likely that exposure to high concentrations of arsenic will damage the lungs. In this experiment, the lung cells of the mice may have shown adaptability, and the experimental time can be extended to make more accurate observations of the mouse lungs.

5. Conclusions

This study investigated the effects of arsenic on lung cells in a mouse model. The results showed the possible role of arsenic in inducing lung inflammation and cell damage, providing preliminary evidence for its contribution to lung disease. By verifying whether neutrophil degranulation is the cause of lung damage caused by arsenic exposure, we have a further understanding of arsenic toxicity. It provides insights into the potential harm of arsenic exposure to human lung cells. This study can not only deepen our understanding of the adverse health effects of arsenic, but also emphasize the importance of addressing environmental pollution as a major public health issue. In the future, this study provides possible ideas for studying clinical diagnostic tools and treatments for arsenic poisoning. In addition, it can make environmental pollution a major issue that receives greater attention. This can also promote the development of new treatments for lung diseases caused by

environmental toxins. In the future, prevention strategies and regulatory measures should be formulated to try to reduce the harm of arsenic exposure worldwide.

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